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# SEASONAL DYNAMICS OF FLEAS ASSOCIATED WITH THE GRAY-TAILED VOLE, *MICROTUS CANICAUDUS* MILLER, IN WESTERN OREGON[1]

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*Abstract.*—A study of the population dynamics of fleas associated with the gray-tailed vole, *Microtus canicaudus* Miller, was conducted on three sites surrounding the city of Corvallis, in Oregon's Willamette Valley. Over a period of 12 months, 22,641 adult and larval fleas representing eight species were recovered from 377 comparable voles and 256 nests. On all sites, adult and larval flea populations experienced spring and early winter peaks followed by drastic summer and midwinter declines. These fluctuations are consistent with the thesis that humidity and temperature are the chief factors influencing flea populations.

This is the third in a series of papers on the fleas that parasitize the gray-tailed vole, *Microtus canicaudus* Miller, the principal species of field mouse inhabiting grassy lowlands between the Cascade and Coast Ranges of western Oregon and Washington. Earlier, the fleas of this vole served to illustrate the use of statistics for measuring interspecific associations of vertebrate ectoparasites (Faulkenberry and Robbins, 1980) and for modeling parasite populations (Robbins and Faulkenberry, 1982). By contrast, this and succeeding papers will be confined to an analysis of flea populations specific to the gray-tailed vole and its immediate mammalian associates.

## DESCRIPTION OF THE STUDY SITES

The three sites selected for this study lie north, south, and west of the city of Corvallis, Oregon, which itself is situated west-centrally in the Willamette Valley, a rich agricultural region characterized by warm, dry summers and cool, wet winters. Since the sites are ecologically and physiographically similar to one another, data obtained from any one site were compared with data from the other two which, in effect, served as controls. Additional criteria used in site selection were accessibility, relative freedom from human interference, and the presence of significant populations of Norway rats (*Rattus norvegicus* (Erxleben)) and house mice (*Mus musculus* Linnaeus).

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Each site is bounded by larger areas of similar terrain permitting free movement of animal populations. In addition to the gray-tailed vole, Norway rat and house mouse, mammals found on all three sites include the vagrant shrew (*Sorex vagrans* Baird), Townsend mole (*Scapanus townsendii* (Bachman)), deer mouse (*Peromyscus maniculatus* (Wagner)), Townsend vole (*Microtus townsendii* (Bachman)), and the introduced Eastern cottontail rabbit (*Sylvilagus floridanus* (Allen)). While various species of grasses account for most of the vegetative cover, larger plants common to all sites are sweetbriar rose (*Rosa eglanteria* Linnaeus), Himalaya berry (*Rubus procerus* Mueller), Northwest nettle (*Urtica lyallii* Watson), Queen Anne's lace (*Daucus carota* Linnaeus), and Douglas' hawthorn (*Crataegus douglasii* Lindley).

The north Corvallis collecting site, hereafter referred to as the North Site, occupies approximately 1.3 hectares of land within the apex of the inverted isosceles triangle formed by the tracks of the Southern Pacific Railroad at the Corvallis Junction. During winter, standing water may persist for long periods in ditches that parallel the tracks. Tall oat-grass (*Arrhenatherum elatius* (Linnaeus) Mertens) is the dominant grass species, covering most of the site and broken only occasionally by clumps of orchard-grass (*Dactylis glomerata* Linnaeus). Because part of this area is used as a public dumping ground, Norway rats and house mice are most abundant here. Being moist, the North Site also supports the largest population of Townsend voles.

Extensive real estate development along the southern edge of Corvallis necessitated several minor shifts in the location of the South Site and effectively curtailed collecting during two months of this study (May–June 1973). However, all southern sites were located immediately east or west of U.S. Route 99W between Millrace Creek and Wake Robin Avenue, and no site exceeded 0.8 hectares in area. Again, tall oat-grass is the dominant grass species, but orchard-grass and a variety of weeds are also abundant. The South Site is only slightly drier than the North Site.

The West Site embraces 0.6 hectares of land along the north side of Philomath Boulevard 1.3 kilometers west of its junction with 53rd Street. Both tall oat-grass and orchard-grass are absent here, their place being taken principally by colonial bent-grass (*Agrostis tenuis* Sibthorp), followed by velvet-grass (*Holcus lanatus* Linnaeus), bristly dog's-tail grass (*Cynosurus echinatus* Linnaeus), meadow fescue (*Festuca elatior* Linnaeus), and small, scattered clumps of tufted hair-grass (*Deschampsia caespitosa* (Linnaeus) Palisot de Beauvois). On this relatively dry site, the Eastern cottontail and Townsend mole are conspicuously abundant.

## SAMPLING TECHNIQUES

Between December 1972 and January 1974, gray-tailed voles and their nests were collected at regular monthly intervals on all three sites. Initially, voles were taken by placing Sherman all-metal live traps (H. B. Sherman,

Table 1. Composition of the adult flea population of the gray-tailed vole.

| Flea species | Nests | | Hosts | |
|---|---|---|---|---|
| | No. | Percent | No. | Percent |
| *Atyphloceras multidentatus* (C. Fox) 1909 | 2,550 | 41 | 100 | 20 |
| *Catallagia charlottensis* (Baker) 1898 | 3,291 | 53 | 252 | 49 |
| *Corrodopsylla curvata* (Rothschild) 1915 | 32 | 0.5 | 11 | 2 |
| *Hystrichopsylla occidentalis* Holland 1949 | 212 | 3 | 25 | 5 |
| *Monopsyllus wagneri* (Baker) 1904 | 36 | 0.5 | 44 | 8.5 |
| *Nosopsyllus fasciatus* (Bosc) 1800 | 71 | 1 | 14 | 3 |
| *Peromyscopsylla selesis* (Rothschild) 1906 | 57 | 1 | 62 | 12 |
| *Rhadinopsylla* sp. | 1 | 0 | 3 | 0.5 |
| Totals | 6,250 | 100 | 511 | 100 |

De Land, Florida) in their runways; however, the winter of 1972–1973 was so cold that most animals captured in this manner died before they could be retrieved. Persistent vandalism, which must be expected when working in a suburban environment, also discouraged this approach. In place of traps, a variety of old boards and panels were scattered at random over each site. Voles seeking shelter under these objects were easily caught by hand. Each vole was then immediately transferred to a large, labeled plastic jar containing fresh grass clippings and pieces of fruit. All jars were fitted with wire mesh lids. Because some voles died or injured themselves in transit or were found naturally injured in the field, not all of them could be used in this study.

Ordinarily, the gray-tailed vole constructs its nest in a chamber located 15–30 centimeters below the surface of the ground (Pearson, 1972); however, should objects be present at the surface the vole will also build under these. Only surface nests were routinely collected for this study, though during the summer of 1973 five subterranean nests were successfully exhumed for comparative purposes. As most fleas require about one month to develop, an effort was made to collect only those nests that had been occupied for at least this time. Each nest and the loose soil below it was swiftly transferred to a labeled, half-gallon Freezette-Flat plastic container (Cole-Parmer Instrument and Equipment Company, Chicago, Illinois) sealed with an airtight lid. If a litter was found, it was removed and notes were taken on the age and number of the young.

In the laboratory, all voles were killed by quickly wrapping them in cotton blankets saturated with chloroform. This technique prevented the escape of any ectoparasites and preserved them in the positions they occupied on their host's body while it was alive. Once dispatched, each vole was placed in a labeled plastic bag and stored at −16°C. The nest fauna was extracted with

Berlese funnels set for 72 hours and equipped with 60-watt Ken-Rad light bulbs. All fleas and their larvae were preserved in labeled vials of 75% ethyl alcohol.

At irregular intervals, groups of 12 voles were removed from cold storage, thawed, and examined for fleas. Though a number of washing and dissolution techniques have been described for the collection of other ectoparasite groups (Hopkins, 1949, pp. 395–398; Lipovsky, 1951; Cook, 1954; Henry and McKeever, 1971), these are unsatisfactory for fleas, which adhere tenaciously to the hairs of their host and are easily damaged by caustic chemicals. During this study, all fleas were recovered by vigorous brushing and careful searching, a process that generally required half an hour per animal. To prevent ectoparasite loss, these operations were performed against a large, white enameled tray.

## RESULTS AND DISCUSSION

Remarkably severe weather prevailed throughout the collecting period. A destructive freeze in December 1972 was followed by an unusually dry spring and a prolonged summer drought. Ten consecutive months of dryness were finally ended by generous rains in September and October and record-breaking rainfall in November. Above-normal precipitation and temperatures characterized December, but the heavy rains of late January 1974 fell on ground that had been solidly frozen earlier in the month, producing serious floods over much of the Willamette Valley. On the whole, it appears that the normal weather patterns for western Oregon were exaggerated during the period of this study.

In 1973, the gray-tailed vole experienced a population peak throughout the Willamette Valley. This was followed in the spring of 1974 by a catastrophic decline after which few voles were seen until the end of the year (R. F. Hoyer, personal communication). Between February 1973 and January 1974, 428 gray-tailed voles—377 of them statistically comparable—and 251 surface nests were removed from the North, South, and West sites. This material yielded 22,641 specimens of eight flea species, including 6,761 imagines distributed as shown in Table 1. For most species, identification of larvae was not possible. Only *Atyphloceras multidentatus, Catallagia charlottensis, Hystrichopsylla occidentalis,* and *Peromyscopsylla selenis* are regular parasites of voles (Hopkins and Rothschild, 1962, 1971). *Corrodopsylla curvata* is a true shrew flea, *Monopsyllus wagneri* is a widespread western deer mouse flea, and *Nosopsyllus fasciatus* is the introduced northern rat flea. Owing to the rarity of *Rhadinopsylla* in collections and the resultant taxonomic confusion within this large genus, the identity and preferred hosts of specimens from western Oregon remain unknown.

Table 2 summarizes seasonal changes in the total flea population on all

Table 2. Seasonal changes in total flea population on the North, South, and West Corvallis Sites.

| | 1973 | | | | | | | | | | | 1974 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan |
| Mean number of fleas per vole | | | | | | | | | | | | |
| North | 0.80 | 0.50 | 1.5 | 0.0 | 0.12 | 0.0 | 0.27 | 0.38 | 1.0 | 1.9 | 3.5 | 1.5 |
| South | 0.77 | 0.37 | 1.3 | — | — | 0.0 | 0.21 | 0.33 | 1.3 | 0.75 | 4.8 | 1.8 |
| West | 1.2 | 1.2 | 2.3 | 0.60 | 0.25 | 0.17 | 0.17 | 0.37 | 0.78 | 2.4 | 1.4 | 1.3 |
| Mean number of larval fleas per nest | | | | | | | | | | | | |
| North | 0 | 20 | 127 | 33 | 5 | 7 | 18 | 24 | 236 | 132 | 52 | 35 |
| South | 77 | 31 | 51 | — | — | 12 | 0 | 26 | 34 | 139 | 112 | 73 |
| West | 15 | 107 | 66 | 37 | 4 | 8 | 0 | 12 | 134 | 65 | 63 | 32 |
| Mean number of adult fleas per nest | | | | | | | | | | | | |
| North | 53 | 65 | 42 | 11 | 5 | 2 | 3 | 14 | 25 | 49 | 71 | 59 |
| South | 45 | 25 | 3 | — | — | 6 | 2 | 9 | 15 | 76 | 86 | 40 |
| West | 15 | 11 | 19 | 10 | 4 | 2 | 1 | 7 | 21 | 33 | 42 | 22 |

three sites. Regardless of species or host preference, fleas were most abundant during the mild, moist months of spring and early winter and least numerous during the hot, dry summer. A midwinter decline also was evident. Thus, in the example of *Peromyscopsylla selenis,* which despite its generic name is typically a flea of microtine rodents (Jameson and Brennan, 1957), 85 (71%) of the 119 specimens in Table 1 were taken during March–April and October–December. On the other hand, *Corrodopsylla curvata* is specific to insectivores (Hubbard, 1947; Hopkins, 1957), but of 43 accidentals obtained from nests and pelts of the gray-tailed vole, 27 (63%) were taken during the peak spring and early winter months. *Hystrichopsylla occidentalis* is an impartial parasite of small mammals within its range (Hopla, 1964), but again of 237 specimens collected, 170 (72%) were from the same peak months. These observations are consistent with Holland's (1949) thesis that humidity and temperature are the principal factors influencing flea populations. Similar results were obtained by Howell (1955, 1957) in his investigations of fleas associated with nests of the desert wood rat (*Neotoma lepida lepida* Thomas) and by Parker (1958) in a study of fleas—particularly the ceratophyllid *Thrassis bacchi gladiolis* (Jordan)—on the antelope ground squirrel (*Citellus leucurus leucurus* (Merriam)). As expected, peaks in larval populations preceded those of adults; the sole departure from this pattern (North Site, April) probably was due to sampling error.

The mean number of fleas per vole or per nest is equivalent to a crude flea index, similar to one proposed early in this century by the British Plague Commission to monitor flea populations on synanthropic rats in India (Hirst, 1926, 1927; Muirhead-Thomson, 1968). The sensitivity of this index can be improved by treating each species separately and by restricting coverage to infested voles and nests (Cole and Koepke, 1947). Both of these modifications will be demonstrated in forthcoming papers, where the population dynamics of each flea species listed above will be discussed in detail.

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